Wisconsin State Legislature

SENATE CHAIR
ALBERTA DARLING

317 East, State Capitol
P.O. Box 7882
Madison, WI 53707-7882
Phone: (608) 266-5830

ASSEMBLY CHAIR
ROBIN VOS

309 East, State Capitol
P.O. Box 8593
Madison, WI 53708-8953
Phone: (608) 266-9171

Joint Committee on Finance
100TH ANNIVERSARY 1911 - 2011

MEMORANDUM

To: Members
Joint Committee on Finance

From: Senator Alberta Darling
Representative Robin Vos

Date: November 16, 2011

Re: UW System Report to JFC

Attached is a report on the 2009-11 Industrial and Economic Development Funds from the University of Wisconsin System, pursuant to s. 36.25(25)(c), Stats.

This report is being provided for your information only. No action by the Committee is required. Please feel free to contact us if you have any questions.

Attachments

AD:RV:jm

UNIVERSITY OF WISCONSIN SYSTEM

Office of the President
1700 Van Hise Hall
1220 Linden Drive
Madison, Wisconsin 53706-1559
(608) 262-2321
(608) 262-3985 Fax
e-mail: kreilly@uwsa.edu
website: www.wisconsin.edu

November 15, 2011

TO: Senator Alberta Darling, Co-Chair
Representative Robin Vos, Co-Chair
Joint Committee on Finance

FROM: Kevin P. Reilly, President

RE: 2009-11 Report on Industrial and Economic Development Funds

Leveraging the resources of the University of Wisconsin (UW) and its strategic initiative, The Growth Agenda for Wisconsin, which will produce more graduates, stimulate job creation and strengthen our communities, is an integral component of the state's economic recovery and future development. One of the tools that the UW uses to ensure that its research mission translates into economic success is the Industrial and Economic Development Research Fund (IEDRF). A modest investment of $1.4 million in the IEDRF resulted in many notable achievements during the previous biennium:

- Thirty funded research projects;
- Corporate partners provided in excess of $1.4 million in additional funding and in-kind support for these projects;
- Data from IEDR projects allowed several faculty to secure federal grants as well as subcontracts with partnering companies, which were able to attract federal Small Business Innovation research (SBIR) grants. The total grant funding totalled over $5.6 million – more than four times the amount of grant money dispersed by the IEDR program during 2009-11;
- Supported projects resulted in eight invention disclosures to the Wisconsin Alumni Research Foundation (WARF), and WARF has applied for at least nine patents from these projects, with additional patents likely;
- The Applied Research Grant (ARG) program, which is administered by UW System Administration, supported twelve prototype development grants and stipends to cover patenting and licensing costs for technologies developed through ARGs;
- The multi-campus Center for Dairy Profitability (CDP), led by UW Extension, continued to develop and deliver interdisciplinary education and applied research to dairy farms and dairy industry service providers, which generate $26.5 billion of revenue annually.

As these projects demonstrate, it is crucial that the state's investments in the UW and the Growth Agenda continue, so that we can build on these, and develop additional, successes. Maintaining the state's commitment to the Growth Agenda will allow the UW to undertake additional

projects that align the university's research and teaching missions with the needs of Wisconsin's business community.

Section 36.25(25) (c), Wis. Stats., requires the University of Wisconsin System to report biennially to the Joint Committee on Finance regarding projects funded as part of the industrial and economic development research program in the previous fiscal biennium and the relationship of the funded projects to the state's economy. The enclosed report is hereby submitted for your review.

If you require any additional information regarding the 2009-11 Report on Industrial and Economic Development Funds, please contact Kristofer Frederick, Office of Budget and Planning (608-262-8939 or kfrederick@uwsa.edu).

Enclosure

cc: UW Board of Regents
Mark Nook, Interim Senior Vice President
Deborah Durcan, Vice President
Freda Harris, Associate Vice President
Petra Roter, Interim Associate Vice President
Kristofer Frederick, Program and Policy Analyst
Rebecca Karoff, Senior Academic Planner, Office of Academic Affairs
Lisa Beckstrand, Academic Planner
Sara Hynek, Department of Administration
Breann Boggs, Department of Administration
Dave Loppnow, Legislative Fiscal Bureau
Emily Pope, Legislative Fiscal Bureau

Industrial and Economic Development Research Fund
2009-11 Biennial Report

The Industrial and Economic Development Research Fund (IEDRF) was established in 1987 to enhance the relationship between UW System institutional research and Wisconsin industrial practices in an effort to promote the state's economic growth. It has supported projects which have assisted a large number of Wisconsin enterprises. Many of these projects continue to improve the competitive position of Wisconsin business.

This report describes the activities supported by the IEDRF for the 2009-10 and 2010-11 fiscal years. The report is divided into three narrative sections and five appendices. The first narrative section details the Industrial and Economic Development Research Program (IEDR), which provides grants to faculty at UW-Madison. This program is administered by the UW-Madison Graduate School. The second section provides an overview of the Applied Research Program, administered by the UW System Office of Academic Affairs. These funds provide grants to faculty throughout the UW System. The final section describes the activities of the Center for Dairy Profitability, an on-going UW-Extension and UW-Madison project that addresses economic challenges to Wisconsin's dairy industry.

Both the IEDR program and the Applied Research Program provide grants which are competitively awarded. Researchers are encouraged to submit technically innovative proposals that are of interest to a broad economic sector and which will immediately benefit Wisconsin's industrial and economic development. All projects are selected based on a combination of scientific merit and the potential for technology transfer. Grant summaries are provided in the appropriate sections.

Four appendices are attached which list all grants, investigators, campus or department, and the amount funded by the IEDR and Applied Research programs. A final appendix notes extramural grants, awarded in support of the work done by the Center for Dairy Profitability.

A. Industrial and Economic Development Research (IEDR) program – UW-Madison Graduate School

The Graduate School administers the IEDR program for the University of Wisconsin-Madison. The IEDR program goals are to stimulate and enhance collaborations between the UW-Madison and Wisconsin firms and to promote economic development in the state. A panel of faculty members employs a competitive process to select technically innovative projects that benefit Wisconsin businesses from proposals submitted by university faculty and staff researchers. Beginning with the 2010-2011 competition, the review panel decided to instruct applicants that they were especially interested in supporting projects with small Wisconsin businesses. The panel also reviews each proposal for scientific and technical merit.

The IEDR program funded 16 projects ($727,741) in fiscal year 2009-2010 and 14 projects ($700,000) in fiscal year 2010-2011. Research objectives and findings for individual projects are summarized in this report. The following points provide a summary of some noteworthy facts and outcomes resulting from IEDR research program:

- In 2009-2010, grants supported collaborations with businesses from the following counties: Dane, Milwaukee, Rock, Shawano and Waukesha. In 2010-2011, the counties of Dane, Fond du Lac, Waukesha and Winnebago had small businesses who participated in IEDR funded grant projects.

- Faculty indicated that IEDR funding has been important to demonstrate state and university commitment to translational research, to solidify research collaborations with companies, and to leverage awards into further funding opportunities. Several PIs indicated that this funding which often directly supports product development is rare, making it unlikely that the research would have been undertaken without support from IEDR.

- Corporate partners often provided additional funding and in-kind support in the form of materials, equipment, and staff time for IEDR projects valued in excess of $1.4 million. This is an amount nearly equal to the amount of grant funding distributed. After the IEDR funding period ended, these collaborations often continued, some with ongoing financial support from the corporate partners.

- Data from IEDR projects allowed several faculty to apply for and receive large research grants directly from federal agencies and subcontracts with partnering companies, who received SBIR grants. Grants received as a result of IEDR research totaled over $5.6 million. This is four times the amount of grant money dispersed by the IEDR program during the two-year reporting period.

- As a result of IEDR research, some collaborating companies plan to hire additional staff, will achieve cost savings, or are in better positions to manufacture and market their products. This provides an economic boost directly to the State of Wisconsin.

- Faculty submitted at least 4 invention disclosures in 2009-10 and another 4 invention disclosures in 2010-11 to the Wisconsin Alumni Research Foundation (WARF). WARF has applied for at least 9 patents from these projects so far, and additional patent applications are likely.

- In addition to faculty and academic staff, several dozen students, both graduate and undergraduate, and postdoctoral fellows worked on these projects. Many of these students received training for hi-tech jobs and left UW-Madison with job offers in technology companies.

- Researchers have published 30 research papers in peer-reviewed journals and conference proceedings, and more than 20 additional papers are either submitted, in progress or planned.

Appendices A and B contain tables that identify the principal investigators, university departments, and the amounts of each project awarded.

IEDR Research Projects, Fiscal Year 2009-2010
University of Wisconsin-Madison

See Appendix A for a list of investigators, departments, cooperating companies, their locations and amounts of the awards.

1. Bridging the Digital Divide to Rural Wisconsin (Principal Investigator (PI): S. Banerjee)
The goal of this project has been to implement a unique cost-effective long-distance wireless technology to allow easy penetration of high bandwidth Internet access services to rural and low population density areas. The approach taken in this work is to utilize the emerging WiMAX technology as a candidate solution this problem that is available for wide-area use. Collaborative strategies between multiple operators are examined to balance costs in connecting rural and sparsely distributed populations. Studies have shown that rural populations are socio-economically disadvantaged, when compared to their urban counterparts, due to lack of easy access to high-bandwidth Internet at their homes. This project potentially

benefits a significant fraction of the people of Wisconsin, and will empower local organizations to bring these services to such populations. We have deployed a WiMAX system in the UW-Madison campus and have defined software-level optimizations that increase range and performance of users accessing Internet-based services through it. We have demonstrated the functioning of this system by making it available to some static users in the Madison area as well as mobile users in vehicles. We enable better performance for users by designing a special multi-interface system that provide connectivity to multiple networks to increase coverage and performance. The results of this work are being submitted as a technical paper to the premier conference in our field (MobiCom 2011). A $350,000 Computing Research Infrastructure grant was awarded by National Science Foundation (NSF) to the PI for ongoing activities related to this project. In addition, Cisco provided $150,000 worth of equipment to make this project possible.

2. Use of System Dynamics as a Decision-Making Tool in Sustainable Building Design (PI: L. Bank)
The objective of this research was to develop a model and methodology for simulating buildings that will be the foundation of a tool that can be used by building designers and building owners to make earlier, more cost-effective, efficient decisions during design of sustainable (or Green) buildings. The second objective of the research was to determine the feasibility of automating this decision process through the use of a protocol that allows decision-making models to interact with Building Information Models (BIM), thus simplifying and economizing the analysis of alternatives in a sustainable building design. Two basic results have come from this research funding. First, the research team has demonstrated and developed sample computer code for a feasible method for automating the incorporation of decision-making models into BIM models. Second, a process has been developed for incorporating a sustainable building rating system information into BIM models. Further development of these two processes will allow for more efficient and quantitative calculation and documentation of green building rating system points during the design of buildings. While the decision-making model itself is not yet ready for use in commercial design, the processes developed in this research could be used by a design firm in some capacity for decision-making immediately upon completion of follow-on research. Use of this tool will make Wisconsin building design firms more competitive in the market for design of sustainable buildings by providing them with earlier, less expensive and more accurate methods to analyze alternatives, make design decisions, and calculate and document green building ratings. The project resulted in an invention disclosure to WARF as well as an invited paper at an international conference in Hong Kong.

3. Solid-State Infrared Lasers for Food-Package Marking (PI: D. Botez)
The primary objective was to improve the overall electrical-to-optical power conversion efficiency of semiconductor lasers emitting in the mid-infrared (IR) by significantly reducing the temperature dependence of their electro-optical characteristics by comparison to those of conventional mid-IR devices. We employed one of our WARF-patented concepts for high-efficiency, mid-IR emitting semiconductor lasers: deep-well quantum-cascade lasers (QCLs); developed the first theoretical model for the temperature dependence of the electro-optical characteristics of QCLs; and invented a new type of QCL: the tapered-active QCL. As a result, we were able to design mid-IR QCLs with overall electrical-tooptical power conversion efficiency values as high as 22%; that is, basically twice the best values obtained from conventional QCLs. The cooperating company, Intraband LLC of Madison, is now in a position to develop products much superior in performance that those currently available commercially. Part of the new products will benefit the plastic-packaging industry and in turn Wisconsin's economy since, in terms of shipments (in dollars), Wisconsin's national rank is #1 in plastic film packaging. The results from this project include a new patent, 3 publications and a STTR award to the cooperating company from the Department of Defense.

4. Monoclonal Antibody Purification Using Simulated Moving Bed Chromatography (PI: R. Burgess)
We proposed to evaluate the use of this exciting new technique and Semba's device in the large-scale purification of a test protein and then monoclonal antibodies (mAbs) we prepare in our laboratory and

then to optimize conditions for using the OctaveTM to carry out a new form of gentle immunoaffinity chromatography. We successfully purified estrogen related receptor alpha by immobilized metal affinity chromatography. We prepared monoclonal antibodies of interest in our lab using both production in mouse ascites and in an animal-free Celline device and succeeded in finding an excellent resin for the mAb purification from both sources. We have explored proper elution conditions and will soon test those optimized conditions and the Octave device to test the utility of SMBC in gentle immunoaffinity purification. The data generated have demonstrated the power of this new approach in protein and antibody purification and provided a strong boost to the ability of Semba to market its new SMBC device both to academic researchers and to biotech and pharmaceutical companies. In the process of using the equipment, we encountered software problems that have now been corrected, resulting in a more robust and reliable device than is now on the market. It is anticipated that at least one publication will be prepared as a result of this work.

5. Improved Cell-based Assays Personalized Medicine (PI: A. Friedl)
Breast cancer growth is governed by bidirectional signaling events between malignant carcinoma cells and non-cancerous host elements (stroma). The overarching goal of this project was to develop patient-specific therapeutic strategies aimed at normalizing the breast cancer stroma and thus inhibit cancer growth. Using an innovative, miniaturized experimental platform, we found that cancer-associated fibroblasts (CAF), connective tissue-type stroma cells isolated from breast cancer patients, stimulate carcinoma cell growth. In most of the cases, the neutralization of a single fibroblast-derived secreted growth factor was sufficient to reverse the growth stimulation. Interestingly, the identity of the required factor(s) differed between patients. These results suggest that the disruption of stromal growth signals might be a feasible novel treatment strategy in human breast cancer but they also highlight the necessity for tailoring this treatment for specific patients. The research was carried out with innovative microscale channel culture devices provided by Bellbrook Labs, Madison, WI. Our work is a prove-of-principle study demonstrating that primary cells can be maintained in these devices. The devices have recently become commercially available (http://www.bellbrooklabs.com/iuvo.html). We are currently following up on our results by expanding the list of molecular targets and by increasing the number of patients. Further, we will investigate at the molecular mechanistic level a result that might explain why a group of drugs known as matrix metalloprotease inhibitors is ineffective in breast cancer patients. The results of this project include 3 published papers and several other in preparation. In addition, a small grant was awarded to the PI through the UW Comprehensive Cancer Center funded by the Department of Defense.

6. Photoelectrocatalytic Oxidation to Inactivate Microbes in Drinking Water (PI: G. Harrington)
The overall goal of this project was to determine the operating conditions required for photoelectrocatalytic oxidation (PECO) treatment units to inactivate 99.99% (4-log) of selected waterborne pathogens. This would provide the manufacturer, a Wisconsin-based startup called AquaMost, with data for product improvement and to help support negotiations with investors and manufacturers. Our research was able to demonstrate that PECO could work as a home-scale drinking water treatment system, and could compete with other available technologies for inactivation of waterborne pathogens. For example, *E. coli* was inactivated at rates several times faster than rates achieved by competing technology. The data also showed that PECO inactivated MS-2 phage, a surrogate for pathogenic viruses, more slowly than competing technology. However, the slower rate was not enough to eliminate PECO from consideration as a viable drinking water treatment device. Results are currently being used by AquaMost in presentations to potential investors and a Wisconsin-based manufacturer of water equipment. Based on the results from this project, the manufacturer is expected to conduct further tests to determine if the product can be sold as a home-scale treatment system in Asian markets. If further tests go well with the manufacturer, sales potential would be well over a million dollars annually. The results of this project include one submitted paper and another being written. In addition, the partnering company has gone ahead with product develop and is negotiating with a manufacturer for the product.

7. Validation of Fertility Gene Effects in a Commercial Dairy Cattle Population (PI: H. Khatib)
Infertility is a major problem for the dairy industry in Wisconsin and the rest of the world. The objective of the research was to identify and characterize genes affecting reproductive performance in dairy cattle. Characterization of such genes could help in improving fertility and health traits in cattle. In order to accomplish this objective, semen samples from bulls with different sire conception rates were provided to our lab by Genex. DNA was extracted from semen and tested for association between genetic markers and sire conception rates of Genex bulls. Analysis of 50,000 genetic markers revealed several genes associated with bull fertility. The identification of fertility genes is expected to have important implications for the dairy industry. Indeed, bulls can be selected for insemination based on their genetic information. Future goal of this research is to investigate the biological functions of the genes indentified in this project and test their relevance to fertility functions. This project has resulted in one manuscript.

8. Implementation of Cross-linked Trypsi Aggregate for High Throughput Proteomics (PI: L. Li)
Our research objective is to develop carrier-free enzyme immobilization for accelerated digestion of protein samples. Specifically, our goal was to employ cross-linked trypsin aggregates to construct a high throughput proteomics platform that offers both off-line coupling to matrix-assisted laser desorption/ionization mass spectrometry (MALDI MS)-based analysis and an efficient on-line proteolysis system coupled to liquid chromatography/mass spectrometry (LC/MS) for enhanced proteomic coverage. We introduced a carrier-free enzyme immobilization technology into proteomics for rapid proteolysis. Cross-linked trypsin aggregates (CLEA-trypsin) were prepared by a simple and low-cost method, showing excellent proteolysis efficiency, improved thermal stability, and reduced enzyme autolysis. A high throughput proteomic strategy was developed by incorporating on-plate CLEA-tryptic digestion and highly-accurate MALDI-FTMS peptide mass fingerprinting. The addition of CLEA-trypsin-based products and the on-line, real-time protein digestion system would be of great value for Promega in proteomics discovery research. Clearly, the growth and success of each biotechnology company in Wisconsin contributes to the overall development and stimulates economical growth of biotechnology and pharmaceutical industry in the local area. The result of this project includes one manuscript.

9. Adaptation of Real Time Medical Imaging Algorithms for Night Vision (PI: C. Mistretta)
The goals of this research project are to identify the feasibility of a product based on image enhancement algorithms used for x-ray dose reduction in the area of night vision image enhancement, investigate image enhancement algorithms improvements in the MATLABTM numerical simulation application, and research into sensor optimization and available image display. The product is feasible given the state of the art and the progression rate of the state of the art in semiconductor computational capability. Existing camera technology could potentially be used and adapted for use in the product. Existing display technology that facilitates light weight operation has been identified. Areas where limitations of the existing computational boundaries are have been identified and additional work has been done investigating acceleration and enhancement of those limitations. This work has resulted in one patent and the cooperating company is pursuing a non-exclusive license.

10. Effective Engineering Design through Computer Modeling and Simulation (PI: D. Negrut)
The behavior of granular material is of great interest in many different industries ranging from the games and film industry to mining and pharmaceutical production. One cubic meter of granular material can have upwards of 1 billion particles; as such, computer simulations of such a large number of particles can be very time consuming or impossible without the use of supercomputers. The introduction of NVIDIA's CUDA (Compute Unified Device Architecture) in February 2006 brought the option of inexpensive parallel computing on the Graphics Processing Unit (GPU) into the picture. The goal of the project was the implementation and validation of discrete particle methods on the GPU to allow for simulation of industrial processes involving granular materials without the cost associated with a supercomputer. The simulation of granular material with over 3 million particles was accomplished using a single GPU card on a typical desktop workstation. Experimental validation efforts were carried out to verify the accuracy

of the granular material simulations. Granular flow experiments showed good quantitative agreement with the simulations in most cases. Large scale granular material simulation will allow for not only better insight into granular flow industrial processes, but also for many other related systems involving granular materials to be simulated. In the case of the cooperating company (P&H Mining), possible simulation applications include: mobility of mining shovels, conveyer belt dynamics and shovels digging into granular materials. This project has resulted in one small grant from NASA for further study.

11. Durable Nanocrystalline Diamond Coated Cutting Tools (PI: F. Pfefferkorn)
The research objective was to improve the adhesion of very thin diamond films (nanocrystalline diamond) on micro-scale cutting tools (micro end mills). The effect of a new method of preparing the [tungsten carbide] tool surface prior to diamond growth was investigated. The carbon ion implantation method creates a carbon-rich layer that results in excellent diamond growth (thin layers with good bonding to the substrate) and eliminates the need for seeding the substrate prior to diamond deposition: i.e., it eliminates one process step. Initial tool wear is determined by the tool's ability to withstand cutting edge fracture early in the milling process. Even after edge fracture (and coating delamination) the diamond-coated tools possesses an increased cutting performance, higher quality surface finish, and a reduced amount of burring when compared to the uncoated end mills. The 1-3 year impact of this research is providing two WI companies (Performance Micro Tool of Janesville, WI and NCD Technologies of Madison, WI) a unique slice of the growing $500 million micro-machining market worldwide. NCD Technologies was formed by a former student of the PI, who was supported on previous IEDR projects. They are poised to be the first to offer true diamond coated micro cutting tools and these diamond coatings on the smallest tools: ones that are not coated at all right now because of the thickness of commercially available coatings. A $150,000 NSF SBIR grant was awarded to one of the cooperating companies (NCD technologies). In addition 5 conference presentations were made and other publications are expected within the coming year.

12. Presurgical Planning & Manufacturing System for Personalized Orthopedic Implants (PI: H-L. Ploeg)
Orthopedic implants and various plates, screws and similar hardware, have substantially improved the quality of life and offer hope to patients confronted with these procedures. Although significant advances have been made, these patients are not well serviced since their diseased or damaged anatomy cannot be adequately repaired with standard sizes and configurations of conventional mass-produced implants. The research objective of this study was to evaluate the accuracy of a patient specific orthopedic device designed from medical image data as compared to the source bone it replaces. Vantus Technology Corporation's goal is to help establish a Center of Excellence in Wisconsin to capture the majority market for Osteosarcoma patients in the US. This will produce approximately $7 million annually if Vantus captures 80% of the market. This project resulted in a manuscript.

13. Validation of Quantitative Biomarkers of Fatty Liver Disease using MRI (PI: S. Reeder)
Non-alcoholic fatty liver disease (NAFLD) afflicts an estimated 80-100,000 million people in the United States, alone, and is an increasingly important cause of cirrhosis, liver failure and liver cancer. The hallmark feature of NAFLD is liver fat, which often leads to inflammation and fibrosis, and ultimately cirrhosis. The overall goal of our work was to develop and validate non-invasive quantitative imaging methods for accurate diagnosis and quantitative assessment of NAFLD, using magnetic resonance imaging (MRI), and to translate these methods into clinical practice. In a close academic-industrial partnership between the University of Wisconsin and GE Healthcare, these quantitative imaging methods (known as IDEAL IQ) were successfully developed, providing a rapid (20 seconds) scan that provides highly accurate measures of liver fat concentration. We have also complete cycle of technology transfer of this imaging method that recently received FDA approval, and expected commercialization in Q4 of 2011 or Q1 of 2012. Importantly, GE was successful in obtaining a marketing indication from the FDA for quantification of liver fat. Upon successful commercialization of this product (exact release date unknown), it is expected that several thousand copies of this application will be sold. There are currently

12,000 scanners in the US alone, and over 30,000 scanners worldwide. Conservatively, it is expected that 2000-5000 copies of this application may be sold in the next 5 years. Applications such as these typically sell at $50-100,000 per copy, leading to potential revenue to GE Healthcare of $100-500 million. GE Healthcare is based in Waukesha, WI. Results from this project include 4 patent applicants, 1 invention disclosure, and 15 published papers. In addition, Dr. Reeder has secured $3.5 million in funding from National Institutes of Health (NIH).

14. Injecting Innovation: Enabling New Markets for Direct Steam Injection Heating (PI: T. Shedd)
The objective of this research was to develop a fundamental understanding of the steam injection process so that direct steam injection heating products could be designed for and sold into new markets and applications. Specifically, the research objectives were to gain an understanding of how the nozzle design impacts temperature distribution and noise generation. This research project resulted in the fabrication of a very unique flow visualization and testing facility with capabilities that no other laboratory, academic or industrial, has. This facility allowed the researchers to develop a simple model for the steam jet behavior and show that this behavior was uniquely tied to the temperature distribution downstream of the injection. In addition, theories of the acoustic noise generation were developed that have been used to develop new steam injection nozzles that hold promise for significantly lowering the noise and instability of commercial direct steam injection devices. According to the cooperating company, this research directly impacts a $1 million line of current products, as well as the expansion of the product line into new markets and applications where previously the devices were unable to operate within noise or stability limits. In addition, it is expected that the results from this work will enable the company and other manufacturers of direct steam injection products to apply the technology to new markets such as improving starch conversion in ethanol production and cell wall destruction in anaerobic digesters. It should be noted that this is an industry that is currently dominated by Wisconsin manufacturers, and the cooperating company has seen steady to increasing sales volume throughout the current economic downturn. This project will result in at least one publication.

15. Accelerated Microcopy and Automated Tracking of Pathology Specimens (PI: L-S. Turng)
The proposed research aims to develop a novel, end-to-end specimen holding device (a micro-injection molded capsule attached to a micropipettor) that holds each and every specimen at all times while enabling simplified laboratory processing protocols that save time and reduce the amount of expensive and toxic reagents required. Since each specimen is held in a unique device, this enables the use of laboratory information management systems (LIMS) for process control to further reduce labor costs by eliminating technicians from onerous documentation demands. Systematic experimental and analytical works have been conducted in collaboration with our industrial partner, Microscopy Innovations, Marshfield, Wisconsin, to design and develop the novel specimen holding pipette devices. Pre-production prototypes of these products have been produced in a collaborative effort as well as exhibited and demonstrated for initial market introduction and product evaluation. Microscopy Innovations launched sales of the resulting products at Microscopy and Microanalysis, August 2-5, 2010 (dates of exhibition), and received lots of attention. They anticipated that about a dozen jobs will be created in Wisconsin within a year of product launch, followed by further growth as the market grows.

16. MRI-Guided Robotic Biopsy System for Breast Cancer Diagnosis and Treatment (PI: M. Zinn)
The project's research objective was to develop a pathfinder MR-compatible robotic breast biopsy system prototype to facilitate vital technical and clinical development that will ultimately lead to commercialization. Specific technology hurdles that were investigated included the development of an MR-compatible actuation approach suitable for imageguided interventional procedures as well as the development of the overall control electronics architecture. A one axis prototype robotic device was successfully developed. Testing demonstrated that the developed prototype was able to achieve the position accuracy required for imageguided interventional procedures. In addition, MR-compatibility was demonstrated. The success of this project has contributed to renewed investor interest in Marvel

Medtech's MR-compatible image-guided interventional technology and may lead to follow-on VC funding and eventual commercialization. The high-margin business model, coupled with the need to respond to rapid technological and clinical changes, heavily favors manufacturing within Wisconsin. The project resulted in one invention disclosure to WARF and a pending SBIR application to NIH from the cooperating company.

IEDR Research Projects, Fiscal Year 2010-2011
University of Wisconsin-Madison

See Appendix B for a list of investigators, departments, cooperative companies, their locations, and amounts of the awards.

1. WiRover: A Technology for High-Bandwidth Internet Connectivity to Vehicles (PI: S. Banerjee)
The goal of this project has been to implement, deploy, and evaluate a new communication technology, called WiRover, that can provide high-bandwidth connectivity to vehicles, thereby enabling a new class of public service applications, that were not feasible before. We achieve this through a unique software design that builds a special on-board computer module that combines services from multiple networks simultaneously (say, all of Sprint, AT&T, Verizon, and US Cellular) to provide unprecedented performance robustness. While the performance of a single cellular network can be fairly spotty and unpredictable in a single location, the aggregate performance across multiple networks can be quite predictable and can sustain high bandwidths smoothly to high speed vehicles. The system is currently been deployed for trials on both Madison Metro buses and Van Galder buses to provide continuous Internet connectivity to its passengers. The project developed unique software-level optimization techniques to aggregate Internet-bound traffic over multiple networks simultaneously. The results indicate that use of multiple simultaneous networks can significant reduce performance outages, and improve data throughputs by a factor of two or more leading to new applications not possible before. One work based on this project was recently accepted for publication at the Internet Measurement Conference 2011 to be held in Berlin in November this year. Through this project, we are empowering two local bus operators --- Madison Metro and Van Galder to provide Internet services on their buses in a manner that was not feasible before. Our trial service has been operational for nearly 1 year now. Various studies have shown that availability of Internet services on public transit vehicles leads to increased ridership. Hence, our efforts can potentially provide significant impact on revenues of both these Wisconsin based organizations. More importantly, as more people take these public buses for various commutes, our technology reduces the carbon footprint of the residents of this state. Further, this technology also won the grand prize in the Wisconsin Governor's Business Plan Competition 2011. The project has resulted in two patents. In addition, WiRover received press coverage both in Madison and Milwaukee.

2. Improved on Chip Diagnosis of Asthma (PI: D. Beebe)
Our research objective was to develop a microfluidic-based lab-on-a-chip technology that can be used to manage and diagnose asthma. We attempt to correlate white blood cell (WBC) migration – a cell type that has been linked to asthma – with the severity of asthma for a patient. The device would ultimately yield a quantitative readout (some numbers) that clinicians could use to help them diagnose the severity of asthma and manage the disease. We have three primary research results, two of which were directly related to the research objectives. First, we successfully designed and characterized a novel, robust, microfluidic chemotaxis device that was used for WBC purification and chemotaxis for humans and mice in 2D on petri dishes as well as on cell monolayers. The platform also was amended for 3D chemotaxis. Secondly, we utilized this platform for a ~60 person patient trial and preliminary analysis suggests a correlation between cell migration and a common asthma diagnostic measure – FeNO. Finally, the platform was amended to an all-in-one toxicology platform, which is the initial focus for a potential future commercial product and company. We are currently seeking funding from NIH, which will form the basis

of a company that would be located in Wisconsin. The company would also potentially lease space from Bellbrook Labs and set up partnerships with local companies such as Promega. The results of this research project include an invention disclosure and patent application. In addition, a couple manuscripts are in preparation and further grants will be submitted in addition to the SBIR grant to NIH, which is pending.

3. Optimization of Wind Turbine Blade Design and Operation (PI: R. Bonazza)
Renewegy, LLC of Oshkosh, WI, is seeking to establish itself as the leader in the manufacturing of wind turbines in the "light commercial range (8-10 m rotor size; 30-40 m hub height; 20-500 kWpower output). This program's main objective was to provide the company with advanced tools to optimize the design of their wind turbine blades and the turbines operating scheme. Our work consists of: an analysis based on an approximate model; numerical simulations based on the Open-Prop software; and state-of-the-art numerical simulations of the airflow past the current blade design using the ANSYS software, available through the Computer-Aided Engineering Center.

4. Egg Antibody to Improve Broiler Performance (PI: M. Cook)
Our laboratory previously developed an egg antibody technology to an inflammatory enzyme called secretory phospholipase A2 (sPLA2) that has been successfully commercialized by a Madison, WI company (aOvaTechnologies, aOva) for cattle, swine, and fish. This product has not worked in poultry. Hence, the objective of this research project was to identify new vaccine strategies that will produce a useful egg antibody for the poultry industry. To date we have created 8 new vaccine products and tested them in growing broilers and found that 7 of 8 failed to achieve our goal (one peptide is currently under additional study). We discovered another protein that "contaminated" the commercial vaccine that may explain current success in other animal species, and we have created five vaccines for antibody testing. We have been granted a 6 month no cost extension due to health problems in chicks from our vendor, and project successful completion of this project in December, 2011. At today's corn prices, a successful antibody product that improves feed efficiency as little as 6% for the boiler industry represents $600 million in cost savings to the US broiler industry. The broiler market is prized in animal agriculture and a product in this area could greatly improve the opportunities of aOva, and increase its sales more than $50 million/yr. Most important, a useful product in the boiler industry would allow aOva to develop a joint venture with global distributors of aOva's antibody product and aid in the export of a Wisconsin product globally. The future goals of this work is to finish the work and determine what peptide antibodies are the most effective at increasing growth rates and feed efficiencies in broilers. We also believe that lessons learned from this project has opened the door for new funding opportunities. The results on this project include two pending grant proposals as well as 2 conference presentations. A publication will be submitted in the near future.

5. Whey-derived Nutraceutical Lipids (PI: S. Damodaran)
The objectives of the research project were to isolate and characterize the composition of the milk fat globule membrane (MFGM) from cheese whey, and to investigate the stability of the MFGM fraction during further processing and storage. An additional objective was to prepare dairy lecithin using MFGM as the starting material. We have developed a simple process to isolate MFGM from cheese whey and analyzed its composition and its oxidative stability under accelerated storage conditions. The cheese-derived MFGM contained about 17-19% lipids and 65-70% protein on dry weight basis. About 50% of the lipids in MFGM were phospholipids. Compositional analysis of the cheese whey-derived MFGM showed that it is a rich source of phosphatidylserine, sphingomyelin, and several known bioactive proteins. At all storage temperatures studied, the spray-dried MFGM was about 1-2 orders of magnitude less stable than the freeze-dried MFGM. Alcohol extraction of MFGM provided a dairy lecithin product with a yield of 14.4% on dry weight basis. The technology enables production of highly desirable fat-free whey protein concentrate (WPC) with excellent functional properties and flavor stability. This will greatly expand its utilization in several food products applications. The MFGM stream resulting from the new

process is a highly valuable by-product containing several nutraceutical lipids and bioactive proteins. This by-product can be marketed as such as a 'functional food' or as a starting material for production of dairy lecithin. This will provide additional revenue to whey processors in Wisconsin and will make the dairy industry highly profitable and sustainable. The emulsifying properties of dairy lecithin developed in this project will be studied and its application as an alternative to soy lecithin in food and pharmaceutical products applications will be evaluated. This project has resulted in one patent application, another invention disclosure as well as two accepted papers and one submitted.

6. Anticryptosporidial Efficacy of Pre-colostrally Delivered Directed Biocide (PI: B. Darien)
Cryptosporidial infection is one of the most common causes of diarrhea in livestock and humans worldwide and results in high morbidity and economic loss to WI calf producers annually. A WI based start-up biotech company, ioGenetics, LLC, has developed novel anti-cryptosporidial compound that can prevent infection. The objective of the study was to evaluate dosage efficacy of 4H9-G1-LL37 in calves experimentally infected with C. parvum. As the study got off to a slow start due to the delays in obtaining USDA Veterinary Permit to import and/or transport Cryptosporidium, and IACUC & Biosafety approval, the study is running behind the schedule originally proposed. Although additional time was granted to complete the remaining third cohort of calves, we have not completed its analysis. Because the trial is blinded, the enrolment codes remain intact, and we cannot analyze the results from the first two cohorts of calves. The awareness of the economic impact to calf producers and recognition of the potential zoonotic transmission of Cryptosporidium spp. in Wisconsin has grown. The upper Midwest states have the highest incidence rates of human cryptosporidiosis in the US, while WI had the highest incidence rates from 1999 to 2002. The importance of this study is underscored by three factors: 1) a WI based company has produced a novel environmentally and food-animal safe preventive drug that has the potential to positively impact the economic loss this calf diseases WI producers; 2) because the disease occurs in more than 40 countries on six continents, this investigation champions the UW Global Health mission statement; and 3) the very high potential for translational application. Future studies will determine an effective dose to prevent clinical cryptosporidial disease, reduce fecal shedding of the parasite, and protect calves against re-infection. This project has been granted an extension so publications and grant submissions have not yet occurred.

7. Development of Online NIR Analysis for Use in Stem Cell Bioreactors (PI: D. Hei)
Induced pluripotent stem (iPS) cells offer great promise as a source of valuable cell types (e.g., heart muscle cells, insulin-secreting cells, brain cells) for therapeutic, drug screening, and developmental research applications. A key hurdle to advancing human iPS cells into clinical and industrial applications is the ability to produce large quantities of cells that consistently meet stringent quality specifications. The goal of this project was to develop a bioreactor for producing large quantities of iPS cells. The primary focus was developing NIR spectroscopy as a new technology for to monitoring the growth and health of the iPS cells as they grow in the bioreactor. In collaboration with Thermo Scientific (Madison, WI), we developed equipment and calibration models that allowed us to monitor quantities of key chemicals in the iPS cell growth medium. Growth and metabolism of the iPS cells correlated with levels of these chemicals thus allowing us to indirectly monitor cell growth and viability. In a second phase of this project, we worked with a student team from Biomedical Engineering to develop a novel bioreactor cassette for growing iPS cells. These cassettes will allow us to perform future small-scale studies with the NIR system where the goal will be to provide real-time monitoring of the cells during growth directly in the bioreactor. Wisconsin has established and maintained a leading role in iPS cell research since the initial discovery of human Embryonic Stem Cells by Dr. Jamie Thomson. A number of new biotech companies with products based on human ES and iPS cells have spun off from the UW-Madison. In addition, several investigators at the UW are currently developing human stem cell therapeutics for a variety of different degenerative diseases. The availability of a bioreactor that is capable of producing large quantities of stem cells could have a very significant impact on both biotech companies and academic investigators in the state of Wisconsin. Moreover, the NIR technology that is being developed

in this project was developed by Thermo Scientific, a local company. The development of new and innovative uses of the NIR technology could have an impact on the ability of Thermo Scientific to expand into new markets. The future work for this project will focus on integrating the NIR monitoring technology with the new bioreactor cassettes to create a bioreactor with real-time monitoring of cell growth. This will allow us to improve current NIR predictive calibration models for analysis of the cell culture medium. In addition, this will enable the development of potential new bioreactor monitoring and control strategies that could have a significant impact on stem cell yield, quality, and safety for clinical applications. An invention disclosure was filed as a result of this project.

8. Enhancing Contractility in Cardiac Myocytes Derived from Human iPS Cells (PI: S. Palecek)
Our objective was to identify factors that regulate development of contractility in cardiac myocytes derived from human pluripotent stem cells (hPSCs). Current methods to produce cardiac myocytes from hPSCs yield immature cells with low contractility. Improved contractile function would yield cells that better represent normal human cardiac myocytes, and improve their utility in disease and drug screening models. We developed an assay to measure cardiac myocyte contractility based on the cells' ability to deform a substrate upon which they are cultured. By varying the mechanical properties of this substrate, we found that cells cultured on an intermediate stiffness, near that of native heart tissue, generate the most force. Furthermore, contractile function declines as cells are maintained in culture for weeks to months. Our partner, Invivosciences, is using the assay we developed to profile contractility of rat cardiac myocytes they incorporate into engineered heart tissues. We are working with them to transition to hPSC-derived engineered heart tissues, which we believe will be more predictive of human heart response to drugs. We plan to identify additional factors, such as applied force and soluble chemicals, which regulate cardiac myocyte contractility. We also have plans to incorporate these cells into tissue patches and compare single cell contractility with tissue contractility. The NIH awarded the PI a $1.3 million grant based on the results of this grant. An invention disclosure was filed and a publication submitted as well.

9. Ultra-Thin Diamond Coatings for Micro Cutting Tools (PI: F. Pfefferkorn)
The research objective was to improve the adhesion of very thin diamond films (nanocrystalline diamond) on micro-scale cutting tools (micro end mills). The effect of a new method of preparing the [tungsten carbide] tool surface prior to diamond growth was investigated. Unlike acid etching, carbon ion implantation does not negatively affect the structural integrity of the tool's cutting edges. In fact, observations show that it improves both the fracture and wear resistance of the cutting edges as compared to an as-received uncoated tool. Two-dimensional machining experiments indicate that a larger percentage force reduction occurs as the size of the cutting tools decreases. NCD Technologies LLC of Madison, WI has hired two new employees (engineer and CEO), is licensing a newly awarded patent from WARF, and has received $500,000 in SBIR funding. NCD technologies LLC plans to diamond coat micro cutting tools for Performance Micro Tool Inc. of Janesville, WI resulting in sales of $1 million within the next 12 months. Improve our understanding of the effect that tool geometry and diamond coating thickness have on the performance of micro cutting tools when machining various materials.

10. Direct Analysis of Digitized Sculptures and Installations (PI: V. Shapiro)
The goal of this research was to determine feasibility of developing and commercializing an integrated system for rapid acquisition and structural analysis of digitized sculptures, art installations and museum displays. The research project demonstrated automated structural analysis directly from several different geometric data formats, both acquired and designed. More generally, the technology allows engineering analysis to be performed on any unambiguous geometric data, enabling an *in situ* analysis and rapid acquisition of physical properties for man-made and manufactured artifacts. The technology is being validated at the J. Paul Getty Museum in Malibu, CA. The commercial potential of the technology is currently being evaluated by a Wisconsin partner company, Intact Solutions, LLC. Successful adaption of this technology has a potential to create a unique commercial opportunity in Wisconsin and nationwide. The developed technology is expected to have wide applicability beyond sculptures and installations,

eventually leading to *in situ* analysis and rapid evaluation of structural properties for a variety of natural and manmade structures. The obtained research results provide the foundation for a new research area in data acquisition and comprehension, which is now supported with a small grant to the PI by the National Science Foundation.

11. Nanomechanical Force Sensor with Feedback for Materials Characterization (PI: K. Turner)
Nanoindentation is a common technique used to characterize the mechanical properties of materials. The technique consists of pressing an indenter into the surface of a sample while measuring the force and displacement of the indenter. From the forcedisplacement data, mechanical properties of the sample can be determined. There is a critical need for new types of force sensors and strategies to characterize soft materials, such as biomaterials, using nanoindentation. The objective of this research project was to investigate the development of novel closed-loop nanoindentation force sensors that utilize feedback to realize transducers with high stiffness and high sensitivity. In this project, the feasibility of a closedloop force sensor that utilizes piezoelectric actuators to provide the feedback control was demonstrated through simulations. A full design for a closed-loop force sensor was developed. In addition to the sensor design, the project also resulted in new strategy for performing and calibrating indentation tests – an invention disclosure report on this new technology will be filed with the university. The results of this research suggest that piezoelectric nanopositioning systems, such as those manufactured by the small business we collaborated with (nPoint, Inc., Madison, WI), can be an effective method of providing feedback in closed-loop force sensors. Thus, the sensors developed in this project may lead to a new market for a product from a Wisconsin-based small business. Based on the results obtained in this 1 year project, we intend to pursue federal SBIR/STTR funding to further develop and demonstrate the sensor technology. In addition, one publication is in preparation.

12. An Ultrasound Method to Measure the Load Bearing Function of Tendons & Ligaments (PI: R. Vanderby)
Develop and evaluate an ultrasound-based method capable of measuring *in vivo* loads in ligaments and tendons. We stretched porcine tendons, *in-vitro*, in a controlled test machine to model human ligament/tendon tissues. After recording the stretch with cine ultrasound images, our objective was to develop a method of image analysis based upon an advanced theory of acoustic wave propagation that computes tissue loads and stiffness. We developed new methods (one for low loads and one for higher loads) where stiffness and therefore load can be predicted from only ultrasound images. These data correlate well with the stiffness and loads measured in our test machine. These data can be obtained when a tendon is isolated (corresponding to an inter-operative measurement), and non-invasively when the tendon is beneath superficial tissues. It is important to note that we analyze images from standard ultrasound systems, so the methods can be rapidly translated. Echometrix is completely focused on the U.S. $1 billion market for musculoskeletal ultrasound, which is increasingly attractive due the dramatic expanse of the useful applications of ultrasound in healthcare provided by equipment miniaturization, cost reduction and improvements in image quality. One of the least penetrated markets (estimated 5% penetration) for ultrasound is musculoskeletal and all of the major manufacturers of mid-sized and hand held ultrasound equipment are driving hard to exploit this market. Previously, the company software (EchoSoft) was more qualitative in nature. Echometrix will incorporate the results of this research into the continued evolution of EchoSoft, its first commercial ultrasound analysis product to improve its capability to evaluate soft tissues of the musculoskeletal system, further differentiate from competitive approaches and drive customer adoption. Echometrix anticipates earning its first revenues in late 2011 and will add two new employees in January 2012. The newly developed ultrasound analysis method for evaluating applied tissue loading is non-invasive and simple. This method can be immediately implemented into ultrasound image analysis software such as EchoSoft (Echometrix, LLC). Then the newly developed algorithm can undergo validation testing via clinical research prior to FDA application and commercialization. The partnering company successfully competed for a National Science Foundation SBIR grant. In addition, the PI is planning several grant submissions as well as a publication.

13. Minimally Invasive Active Limb Deformity Correction Device (PI: M. Zinn)
The objective of the IEDR project was to develop a working prototype of a minimally-invasive active bone deformity correction device, primarily for use in early-stage performance testing and clinical experimentation. While the prototype device to be developed will not be suitable for immediate commercialization, it will allow for vital technical and clinical evaluation, which will ultimately enable its commercialization. The PI has developed an active bone deformity correction device prototype for the treatment of complex limb deformities in children. The prototype device is implantable, allows for general deformity correction, including lengthening and two angular degrees of freedom, and is capable of measuring internal forces and moments that occur during the distraction process. Clinical feedback received while presenting our results at the Limb Lengthening and Reconstruction Society meeting in Chicago (July 2011) was very favorable and suggested that further development and commercialization of the device could be successful. Such an outcome would have significant economic impact to the state of Wisconsin, including the potential creation of additional engineering and manufacturing jobs. Currently the prototype device is undergoing development testing with the purpose of evaluating the device's performance as well as developing the control and estimation algorithms required. The PIs will be submitting an NIH STTR grant in the spring of 2012 to support 2nd generation prototype development and early-stage animal trials. A new invention disclosure will be made to WARF this fall. In addition, one publication has been accepted and another submitted.

B. Applied Research Program

Applied Research Program projects are funded through a competitive process administered by the UW System Office of Academic Affairs and the WiSys Technology Foundation. The colleges and universities in the UW System seek to serve the public through a variety of educational services and scholarly contributions to society. Funding applied research is necessary to advance the Wisconsin Idea and the UW System's Growth Agenda which seeks to contribute directly to the growth of the economy in the state of Wisconsin through the production of new knowledge.

The WiSys Technology Foundation, Inc., derives its mission, goals and objectives from the charge of its parent corporation, the Wisconsin Alumni Research Foundation (WARF). WARF's mission is to support research at the University of Wisconsin-Madison by protecting and licensing inventions created by UW-Madison scientists, and returning the licensing proceeds to fund further research at the university. The specific mission of WiSys, founded in 2000, is to support research and educational programs with high potential economic impact, particularly at the UW System comprehensive campuses and the UW Colleges. This support also includes funding for prototype development geared for commercial success. Since 2005, a part of the overall budget for the Applied Research Program has been made available to WiSys to assist in their efforts to patent and license research discoveries.

The Applied Research Grant program is quite competitive. Principal investigators from UW System institutions submit proposals documenting their realizable applied research goals and objectives and carefully document funding needed to achieve outcomes that may lead to patent production, technology transfer, and entrepreneurial impact. All proposals are reviewed and rated by a panel comprised of representatives of the private sector with expertise in business and technology, a representative from WiSys, and a staff member from the UW System Office of Academic Affairs. In addition to the quality of the research design and likelihood of successful completion, a major criterion for selection and funding is the likelihood of a positive impact of the project on Wisconsin's economy and industry-research partnerships as well as technology transfer.

In 2009-10, 33 applications for funding requesting a total of $1,440,898 dollars were received. Eight (8) UW campus proposals, some of them collaborative and interdisciplinary, were funded in the total amount of $325,055. Further funding included a grant to WiSys to support 6 prototype development grants and a stipend to cover patenting and licensing costs for technologies developed with the support of the Applied Research Grant Program.

In 2010-11, 33 applications for funding requesting a total of $1,475,938 dollars were received. Nine (9) UW campus proposals, some of them collaborative and interdisciplinary, were funded in the total amount of $398,454. Further funding included a grant to WiSys to support 6 prototype development grants and a stipend to cover patenting and licensing costs for technologies developed with the support of the Applied Research Grant Program.

Applied Research Program Awards, Fiscal Year 2009-10

See Appendix C for a list of investigators, departments, and amounts of the awards.

1. Toward Industrial Scale Fabrication of Nanowire-Based Devices (PI: Joseph Wu, UW-Platteville)
The major research objective is to develop core technologies, which enable the industrial-scale production of nanowire-based devices for applications in next generation of power supply, refrigerators, sensors, and computers. Like a transistor as basic unit of a computer, an aligned nanowire array is the basic unit for the nanodevices, such as solar cells, thermoelectric modules, sensors, and nanoscale field effect transistors. We propose to develop enabling technologies for the mass production of the prototype nanodevices, advancing the nanotechnology in the aspect of the nanomanufacturing practices.

2. Development of Microscale Assays to Screen for Novel Anthelmintic Drugs (PI: J. Miskowski, UW-LaCrosse)
This project aims to develop two microscale assays that utilize the non-parasitic nematode *Caenorhabditis elegans* to efficiently screen a unique library of fungal extracts for anthelmintic activity. Anthelmintics are a group of drugs that treat parasitic worm (nematode) infections, and the widespread emergence of strains that are resistant to available anthelminitics has posed a serious threat to humans in developing countries and the livestock industry worldwide. There is a pressing need for new anthelminitics with novel modes of molecular action to be identified and *C. elegans* has been proven to be a superior model system for his work. This project will provide the inroads to a long-term endeavor that could result in a highly marketable anthelmintic agent.

3. Development of Two-Dimensional Metallorganic Networks for Potential Application in Photovoltaics (PI: Nathan Bowling, UW-Stevens Point)
The world sits poised on the cusp of a major energy crisis. The oil disaster in the Gulf of Mexico is the most recent—and stark—example of our precarious energy situation. However, the key to solving our energy crisis does ***not*** lie in a R&D race scattered across a variety of instiutions; rather, it lies in the synergism of multiple disciplines and researchers tackling a common problem. The research groups at the University of Wisconsin-Stevens Point are working together to develop a unique hybrid metal-organic material with the potential to act as a superb solar-capture device. Development of new technologies in solar energy will put Wisconsin in a position to market these advances to the world, increasing state income and improving the job outlook for highly trained Wisconsin graduates looking for high-paying jobs in the state.

4. High Performance Electrical Storage EES Devices (PI: C. Gibson, UW-Oshkosh)
Supercapacitors are electrical energy storage devices that offer higher power and longer cycle-life than batteries. However, supercapacitors have much lower specific energy (ca. 5 Wh/kg) than rechargeable batteries (> 25Wh/kg), and this severely limits their use. Attempts to improve specific energy in supercapacitors commonly rely on development of new high-performance electrode materials, but it is doubtful that this alone will be sufficient to increase specific energy to levels that can be provided by batteries. Researchers at the UW-Oshkosh and Oshkosh Nanotechnology LLC recently developed a novel device architecture, which is designed to substantially improve supercapacitor energy density. By combining this new architecture with high-performance electrode coatings, specific energies greater than 20 Wh/kg are accessible using either aqueous or nonaqueous electrolyte. Fine tuning the device is expected to increase specific energy to between 40 and 70 Wh/kg. Increasing specific energies to this level opens opportunities for use in applications that require both high power and high energy, such as: (1) power systems for electric vehicles; (2) peak-shaving systems for smart grid applications; and (3) power supplies for hand-held power tools and portable electronic devices.

5. Nanoscale Corona Discharges (PI: J. Chen, UW-Milwaukee)
A PIC-MCC simulation code was developed to predict distributions of electrons and ions in the atmospheric corona discharge. Both positive and negative dc corona plasmas produced from a thin wire discharge in dry air are modeled using a PIC-MCC approach. The PIC-MCC simulation accounts for various important collision processes between electrons and gas molecules such as momentum transfer, excitation, dissociation, ionization, and attachment. Distributions of electron number density and electron kinetic energy are numerically determined. The PIC-MCC model suggests the validity of the local approximation used to solve the Boltzmann equation in the prior continuum model and the rate information for photoionization and photoemission critical to the production of secondary electrons in the corona discharge. Superior to the continuum model, the PIC-MCC model is applicable to discharges ranging from microscopic to macroscopic. This modeling capability can thus be used to study corona discharges from nanostructures and across microscale or nanoscale gaps. Compared with the conventional discharges employing micro- or macro-scale electrodes, the corona discharge from CNTs could initiate and operate at a much lower voltage due to the small electrode diameter, and is thus energy-efficient. Most importantly, the CNT discharge is environmentally-friendly since no ozone was detected due to the significantly reduced number of electrons and plasma volume generated by CNT discharges. The resulting discharge current density depends on the CNT loading. Contrary to the conventional wisdom, negative CNT discharges should be used to enhance the current density owing to the efficient field emission of electrons from the CNT surface. Carbon nanostructures, i.e., carbon nanowalls (CNWs), have been successfully grown on conventional discharge wires (stainless steel/SS, or tungsten wires) for use as corona discharge electrodes. The new discharge can initiate at a much lower voltage with significantly lower ozone production. An invention disclosure on this technology is in the process of being filed.

6. Polymers and Copolymers with Controlled Bioresorption for Biomedical Applications (PI: J. Droske, UW-Stevens Point)
The main goal of the proposed work is the preparation of bioresorbable polymers and copolymers. The unique feature of the proposed polymers and copolymers is that they will have a range of resorption rates. These materials will offer superior properties to materials that are currently available, since the rate of bioresorption will be able to be fine-tuned to the specific biomedical application. This will lead to the development of commercially-viable resins that can be used as bone adhesives and bone replacements, arterial stents and plugs, and other applications such as scaffolds for tissue engineering applications. Poly(lactic acid), poly(lactic acid/glycolic acid), and poly(propylene fumarate) are among the promising bioresorbable materials for biomedical applications.1 These materials have been used in a variety of applications, such as bioresorbable stents and bone cements, and have been employed in bone replacement surgery. While *in vitro* studies of the above materials are promising, *in vivo* use of the

materials prepared to date sometimes has been complicated by unexpectedly short or long degradation times. The synthesis of these polymers is versatile and allows for the preparation of polymers having a range of properties, including variable degradation times. The polymers have been characterized by NMR, IR, and GPC, and mechanical property evaluation is in progress. It is expected that these materials will find use as bioresorbable scaffolds for tissue growth, both *in vitro* and *in vivo*, and for applications in which a reusable and recyclable thermosetting resin is desired. The materials are especially well-suited for applications requiring high transparency / optical clarity.

7. Screening for Potentent Attenuators of Heart Failure Progression Using a Zebrafish Heart Failure Model (PI: C. Huang, UW-River Falls)
Our group developed a model of induced acute heart failure using zebrafish embryos. Several lines of evidence had been gathered to show remarked similarities between our zebrafish heart failure model and human heart failure. We attempted to use the model for drug discovery by looking for any compound that can attenuate the heart failure in the AA-treated zebrafish embryos. We first isolated the anti-inflammatory drug NS398, which has been reported with a similar effect in a mouse heart failure model. Confirming the apparently conserved mechanisms involved in heart failure, we found the drug NS398 to attenuate heart failure in zebrafish as seen by others in mice. Subsequent work saw attenuation from several other compounds. Two of them happened to also reduce pigmentation. A third compound showed capacity in suppressing inflammation as NS398. A series of paired experiments suggest that these compounds function along more complex pathways than previously thought. Recent results from real time PCR experiments further support these ideas. Together, our zebrafish model proves to be a very effective approach for heart failure study and drug discovery.

8. A Role for dbl-b E3 ubiquitin ligase in the Balance between Tolerance and Autoimmunity (PI: J. Lyons, UW-Milwaukee)
Multiple Sclerosis (MS) is common causes of neurologic disability thought to be initiated by nyelin-reactive CD4+ T cells. The myelin-reactive T cells induce an autoimmune attach on the myelin sheath surrounding central nervous system axons, resulting in the signs and symptoms characteristic of MS. Although myelin-reactive CD4+ T cells have been isolated from both MS patients and healthy donors, data suggest that these cells have been previously activated in MS patients. Strict control of T cell activation is necessary to prevent autoimmunity. The Cbl-b protein governs T cell activation, preventing immune activation in the absence of the requisite signals. Lack of Cbl-b protein, or low levels of Cbl-b protein, could allow for T cell activation in the absence of the requisite signals. Lack of Cbl-b protein or low levels of Cbl-protein could allow for T cell activation in the absence of the normally required signals leading to autoimmunity. Preliminary data demonstrated decreased Cbl-b protien expression in MS patients compared to healthy donors. The proposed study seeks to further characterize Cbl-b protein mRNA and protein expression by CD4+ cells isolated from MS patients and healthy donors by quantitative PCR analysis and Western blost. The role of microRNA in regulation og Dbl-b protein expression will be investigated by QPCR. Finally regulation of Cbl-b protein activity by phosphorylation and ubiquitination will be investigated by Western blot of immuno precipitated samples. These studies could lead to the identification of biomarkers and novel therapeutic targets for MS in particular and autoimmunity in general. This project is a collaboration between UW Milwaukee and Marshfield Clinic.

Applied Research Program Awards, Fiscal Year 2010-11

See Appendix D for a list of investigators, departments, and amounts of the awards.

1. Development of Fluorescently Labeled Titanium Dioxide Nanoparticles to Enhance Cleaning and Bio-decontamination of Surfaces (PI: Eric Brown, UW-Whitewater)
Humans are often exposed to unwanted biological modifications or agents in the form of cancers, viral infections or bacterial infections that may negatively affect their health. Biologically and chemically modified nanoparticles are gaining much attention as a new tool to target and destroy such unwanted biological agents. Surface modifications of TiO_2 nanoparticles enable visible light (versus ultra-violet light) activation of the nanoparticles leading to degradation of neighboring biological structures, thus broadening the scope of their applications. Successful surface modification of nanoparticles is demonstrated through sedimentation, spectrophotometry, and gel electrophoresis techniques. We show that visible light activation of surface modified TiO_2 nanoparticles leads to degradation of plasmid DNA *in vitro* and growth inhibition of bacteria in culture. Additionally, alterations in the integrity and distribution of membrane associated proteins are detected via fluorescence confocal microscopy in cells exposed to perinuclear localized surface modified TiO_2 nanoparticles that were photoactivated with visible light. Our investigations clearly show that surface modifications on TiO_2 nanoparticles can enhance the photoreactivity of TiO_2 nanoparticles by allowing visible light activation. These findings of our study suggest the therapeutic use of surface modified TiO_2 nanoparticles in diverse applications such as the creation of self-disinfecting surfaces and cancer research.

2. Development of Two-Dimensional Metallorganic Networks for Potential Application in Photovoltaics: Synthetic Avenues to Processible Materials (PI: J. D'Acchioli, UW-Stevens Point)
The world sits poised on the cusp of a major energy crisis. The oil disaster in the Gulf of Mexico is the most recent—and stark—example of our precarious energy situation. However, the key to solving our energy crisis does ***not*** lie in a R&D race scattered across a variety of institutions; rather, it lies in the synergism of multiple disciplines and researchers tackling a common problem. The research groups of Professors Nathan Bowling and Jason D'Acchioli at the University of Wisconsin-Stevens Point are working together to develop a unique hybrid metal-organic material with the potential to act as a superb solar-capture device. This presentation will both highlight the potential properties of the material, as well as emphasize the work's direct impacts on the state of Wisconsin.

3. Laser Focused Ablation System for Artificial Hip Stem Removal (PI: B. Ezenwa, UW-Milwaukee)
Project objective is design and development of new medical tool to enable orthopedic surgeons remove artificial hip stem without collateral damage to the cortical bone and minimum effect on the spongy tissues. The technology solution embodies specialized laser delivery system constrained for ablation along the length of the prosthetic stem. Special features include novel friction guide control system, curved ended distributed delivery nozzles, and intensity gaited and other parameters to provide solution to the clinical problem. Design in SolidWorks will be evaluated and simulation in COMSOL Multiphysics before creating the prototype. Bench test will be conducted with the combination of MIMICS and other enabling hardware.

4. Metabolic Engineering of Isoprene Production in a Halotolerant Cyanobacterium (PI: T. Kallas, UW-Oshkosh)
Because of escalating costs, climate change, and political uncertainty associated with fossil fuels, the Pentagon has identified development of carbon-neutral biofuels as a national-security imperative. Microalgae can help meet this need because they efficiently capture enormous amounts of solar energy and convert atmospheric carbon dioxide (CO_2) into carbon polymers. Modification of these pathways holds great potential for production of feedstock chemicals and carbon-neutral biofuels. One such feedstock is isoprene (C_5H_8, 2-methyl 1,3-butadiene), a precursor for synthetic rubber and high-density,

liquid aviation fuels. Our goal is to produce isoprene in *Synechococcus* PCC 7002, a rapidly growing, high-light and halo-tolerant cyanobacterium. Isoprene can be made via the 2-C-methyl-D-erythritol 4-phosphate (MEP) pathway whose products are isopentyl diphosphate (IPP) and dimethylallyl diphosphate (DMAPP). Cyanobacteria possess the MEP pathway but lack the key isoprene synthase (IspS) enzyme for converting DMAPP into isoprene. We have introduced and expressed plant and bacterial *ispS* genes and cyanobacterial, 'codon-optimized' *ispS* and MEP pathway genes in *Synechococcus*. Our goal is to develop *Synechococcus* strains for commercially viable isoprene production powered by solar energy conversion and atmospheric CO_2 utilization. A further goal is to develop algal bioreactors that use industrial waste, gas streams as the CO_2 source for efficient algal growth.

5. Toward Prdouction of Hybrid TIO2 Nanowire Graphene Elctrodes for Advanced Batteries (PI: K. Kilian, UW-Platteville)
The dependence of the United States upon imported oil and concern about the release of greenhouse gasses into the atmosphere has spurred a search for alternative means of generating and storing electric power. Two key efforts center around the personal automotive fleet and ways to store energy produced by solar and wind power. The battery as a device for energy storage and delivery is of great importance. In this proposal we plan to demonstrate a performance leap in battery capabilities by building upon our existing IP that was developed at UW-Platteville and UW-Stevens Point to improve performance of lithium ion battery electrodes. By using a combination of grapheme and graphene coating technology (from UWP) and templated mass production of titanium dioxide nanowires (a process developed at UWSP) we can simultaneously improve both parts of existing electrode technology in both price and performance: graphene instead of carbon and nanocrytalline TiO2 nanowires instead of bulk precipitated oxides. Starting with proof of principle fabrication our raw nanomaterials, of the electrodes themselves and finally small coin cells, we will work toward establishing joint research ventures with existing Wisconsin battery manufacturers such as Ray-O-Vac, Johnson Controls and ZBB by the second or third year.

6. Nanoarray-based Optical Sensor (PI: N. Kouklin, UW-Milwaukee)
Low—level acquatic pollutants create many severe health and environmental hazards and are ubiquitously found in freshwater systems in the U.S., and the Great Lakes in particular. These pollutants are very expensive to detect and inconvenient to monitor. Herein, we propose to develop and use a novel nanoporous, template-based architecture for continuous, Raman-based detection and monitoring of small traces of chemical compounds present in the aqueous systems. The approach uniquely offers such fundamental advantages as dramatic increase in signals based on nano-SERS-effects, reduced sensitivity to spatial fluctuations (due to Brownian motion of analyte molecules) and improved light coupling efficacy, all of which is called to dramatically enhance the signal to noise ratio thus enabling achieve sensitivity limits down to 10-9 M as demonstrated by preliminary results. Within the course of the studies we intend to 1) build a prototype of novel three-dimensional nanostructured substrate, that can enable both detection, analysis and remote monitoring of the trace concentration of chemicals in water using Raman spectroscopy; 2) test the sensor's detection limit 3) test the sensor's capabilities in different aquatic environments including freshwater via sampling and field placement 4) prepare undergraduate and graduate students.

7. New Warfarin-Based Oral Anticoagulants (PI: D. Lewis, UW-Eau Claire)
The vitamin K 2,3-epoxide reductase (VKOR) is the pivotal enzyme in the vitamin K cycle that recycles vitamin K in the body. Inhibition of this enzyme has many effects, the most obvious of which is inhibition of coagulation. Warfarin has been used as a rodenticide for nearly seven decades, and an oral anticoagulant for over six decades, and yet it still remains a challenge to use because the factors affecting stable dosing in individuals still remain incompletely elucidated. Our discovery of useful adjuvants of warfarin anticoagulation has provided the incentive to re-visit the warfarin question, with potential opportunities in both science and economic development.

8. Entrepreneurship in the Native American Populations in Wisconsin: Barriers, Issues, Policies and Opportunities (PI: M. Russ, UW-Green Bay)
The Native American populations in a number of counties in Wisconsin are suffering from extremely high unemployment as well as high poverty rates. For example, Menominee County was ranked the thirteenth poorest county in the country with 8.2% of its population below poverty level in the 2000 census, and 14% unemployment in 2003. This research proposal offers to map the entrepreneurial nature and the status of entrepreneurship within the tribes, focusing on the barriers, the issues, and the impact of existing policies, and will propose a number of solutions, utilizing external and internal opportunities. The research will propose a comprehensive solution that will encompass the educational, social, political and economic aspects of entrepreneurship in Wisconsin's Native American tribes and their environment, responding to the need to increase the rate and the success of Native American entrepreneurs.

9. Fabrication and Evaluation of Photocatalytic PEM Hydrogen Fuel Cells (PI: M. Zorn/K. Smith, UW-Green Bay/UW-Stout)
Hydrogen proton exchange membrane (PEM) fuel cells are one of the most common types of fuel cells currently in use. These fuel cells convert hydrogen and oxygen to water and liberate energy in the process. The reactions are typically facilitated by a platinum-based catalyst. There are several problems with using platinum-based catalysts that have limited the widespread use of hydrogen PEM fuel cells. First, platinum is a precious metal that has high cost and availability limitations. Second, platinum-based catalysts are susceptible to poisoning by carbon monoxide. In this research, a photocatalyst and light sources replace platinum as the catalyst used to facilitate the chemical reactions. The main objectives of this project are to fabricate a photocatalytically active hydrogen PEM fuel cell and to evaluate the performance using a variety of different photocatalyst alternatives to platinum. A photocatalytic fuel cell has been fabricated and the performance has been evaluated with a limited number of photocatalyst materials. To date, the research project has shown proof-of-concept that the photocatalyst materials are able to facilitate the necessary reactions, and that the photocatalyst-coated electrodes are proton conductive and electrically conductive. Future research will focus on synthesizing and evaluating a variety of additional photocatalyst formulations.

C. Center for Dairy Profitability (UW-Extension/UW-Madison)

The University of Wisconsin Center for Dairy Profitability (CDP) is a multi-campus Extension unit with faculty and staff at UW-Madison, UW-Extension, UW-Platteville, and UW-River Falls. The CDP develops and delivers effective interdisciplinary education and applied research to dairy farms and dairy industry service providers resulting in sustainable, profitable decisions, and a healthy and progressive dairy industry in Wisconsin. Mark Stephenson, Director of Dairy Policy Analysis, UW-Madison, is also the Director of the CDP.

The CDP receives funding from the Industrial and Economic Development Research Fund (IEDRF). In 2010-11, the IEDRF provided $358,182 to fund 3.18 FTEs that were allocated as follows: 2.49 at UW-Madison; 0.29 at UW-Platteville; and 0.40 at UW-River Falls, along with funding to cover the cost of supplies and other expenses at the center location on the UW-Madison campus.

The economic success of Wisconsin's dairy industry contributes $26.5 billion of dairy revenue annually—a rate of more than $50,000 per minute. Every job in dairy supports an additional 1.23 jobs elsewhere in the Wisconsin economy. This work force depends largely on the knowledge and management skills of dairy farmers and agribusiness professionals who work with them. Their decisions will determine whether the state's dairy industry is competitive and prosperous over time. Informed management decisions are a key to dairy farming's economic success. The CDP's emphasis is on educational programs

that enhance the management skills and decision-making abilities of dairy producers and others who assist them in making management decisions. It is the vision of the CDP to be the preeminent academic institution empowering farm managers toward profitable decisions. To this end, the CDP will: 1) enrich the quality of life for farm owners, operators, employees, animals and industry stakeholders; 2) collaborate with universities and industry to identify, develop, and supply a diverse clientele of farm managers and service providers with research-based information and best-management practices; 3) create a work environment that is challenging, rewarding and fun, and 4) disseminate our products through traditional means and cutting edge technologies. The core values of the CDP are diversity, sustainability, planning, collaboration, and quality of life.

This section describes the CDP's educational programs. It also contains examples of how the CDP facilitates the development of multi-disciplinary educational programs and partners with other agencies such as the Department of Agriculture Trade and Consumer Protection and previously, the Department of Commerce that share its goal of enhancing the profitability of the dairy businesses and enhancing business development in Wisconsin and throughout the world.

The Center for Dairy Profitability leverages its limited resources by cultivating key collaborations with professionals and organizations in the agriculture industry throughout Wisconsin. CDP staff work in conjunction with UW-Extension agriculture agents to develop educational programs, materials, speakers, and financial support for programs to help dairy and agricultural producers. Equally important is the relationship between CDP and the Lakeshore and Fox Valley farm management associations. The majority of the farms in the AgFA© database are gathered through these two associations. Wisconsin Technical College System (WTCS) farm business instructors also collaborate with the CDP in providing financial record-keeping workshops and financial analysis for dairy producers in all parts of the state. Other collaborations include:

- Farm Credit Services: Badgerland & AgStar
- Farm Service Agency (FSA)
- Professional Dairy Producers of Wisconsin (PDPW)
- Dairy Business Association (DBA)
- Wisconsin Cheese Makers Association
- Wisconsin Department of Agriculture, Trade & Consumer Protection (WDATCP)
- Wisconsin Farm & Rural Appraisers Association
- Wisconsin Frame Builders Association
- Wisconsin Custom Operators Association
- Grow Wisconsin Dairy Team (WDATCP)
- Grow Wisconsin Farmers Working Group
- Dairy 2020 (formerly Wisconsin Department of Commerce, now WDATCP)

Economics of Dairy

Farm Financial Management and Financial Benchmarks

The CDP works with the Lakeshore and Fox Valley Farm Management Associations, UW-Extension Agents, and Wisconsin Technical College System (WTCS) instructors and others on a farm financial management, records and benchmark project to increase the knowledge of the economic and financial operations of dairy farm business. This program is an integral part of the mission of the CDP. The records gathered by all the entities are used to compute costs of production of dairy farms and selected financial measures such as return on assets, return on equity, debt to asset, etc. These performance measures are widely used by county agents, lenders, policy-makers, and agribusiness professionals who work with producers on economic related problems. Since 1999, the AgFA© database has served dairy

producers and others to summarize and analyze the annual financial performance of farm businesses. AgFA© allows individual farmers and/or their advisors to compile annual financial reports and to compare their farm's performance to the financial performance of contemporaries. CDP staff analyzes the records of dairy producers and assesses the costs of production and financial performance of dairy farms in Wisconsin. These analyses, which are on the CDP Website, are used extensively in dairy extension programs intended to help dairy farm managers become better managers and more profitable.

Dairy Markets and Policy

Dairy Markets and Risk Management

Mark Stephenson, Director of the CDP, has given numerous presentations to farm groups and agribusinesses around the state to provide an update on the current state of and the outlook for milk prices. Milk price volatility has created a difficult business climate for dairy farms today. The research into the causes of this volatility and ways in which it can be managed have been presented many times. Understanding the emerging role of the U.S. dairy sector in world markets has been an important part of this program effort.

Policy Options for the Farm Bill

The Food, Conservation and Energy Act of 2008, otherwise referred to as the current "Farm Bill," is set to expire in 2012. As agricultural regions, and the commodities they represent, consider the upcoming debate that will forge policy for the next five years, Wisconsin's dairy industry has been actively working to understand and frame the policy discussion. Mark Stephenson has met many times with the Wisconsin Farm Bureau, Dairy Business Association, Wisconsin Cheese Makers, and the Midwest Dairy Coalition to provide analyses and offer insights about various proposals.

Extension Educational Programs

The CDP is involved in a variety of management education programs that are intended to teach farm managers and agribusiness professionals about practices to improve the performance and profitability of farm businesses. The following is a brief summary of some of these programs.

Agricultural Land Values

Arlin Brannstrom (CDP Farm Management Specialist) worked with the Wisconsin Chapter of the American Society of Farm Managers and Rural Appraisers and the Wisconsin Department of Revenue to tabulate and identify trends in agricultural land values. Land values are an important cornerstone of farm financial strength. Land values are also a major factor in determining land rental rates. Arlin is working with other North Central Regional Agricultural Economists to develop new publications and teaching curriculum dealing with determining and negotiating equitable land rental rates.

AgVentures

The *AgVentures* program, coordinated by Jenny Vanderlin (UW-Madison), is a fee-based management education program for farm managers. Through this program, farm managers learn about management concepts and their application to the problems they face when operating their farm businesses. *AgVentures* has been designed to provide these farm managers ample opportunities to familiarize themselves with a number of management topics. Using hands-on activities and case studies, farm managers learn about management concepts and their application to farm management issues. Farm managers can choose from six modules: Got Risk? (risk awareness), Building a Vision (financial management & strategic planning), Human Resource Management, Business Arrangements & Farm Transfers, Dairy Price Risk Management and Grain Marketing. Each module contains approximately 15-

20 hours of curriculum and is available on CD-ROM or through the website: (http://cdp.wisc.edu/*AgVentures*.htm).

Dairy Modernization and Technology Adoption

According to the Wisconsin Agricultural Statistics Service (WASS), the number of Wisconsin dairy farms continues to decline. By the end of 2007, the number had fallen to approximately 14,400, with an average herd size of 86 cows. Most of the farms (11,600, 81%) with less than 100 cows are still operating with tie/stanchion stall barns, and associated feeding, milking, and manure handling procedures. These systems are labor intensive and inefficient. The majority (68%) of farmers in this group are between 40 and 60 years of age. Over half of the farms with fewer than 200 cows plan on making investments in housing, milking, feed storage or manure handling facilities in the next 5 years. As these farmers struggle with the future of their dairy farm operations, they need information and education on available options. David Kammel and the CDP staff, in cooperation with the UW-Extension Dairy Team, provides information, decision aids, and educational programs that allow farmers to determine whether and/or how to adopt technology and modernize and permit farmers to develop their businesses, enhance profitability, and improve their quality of life. Several grants are being used to collect financial record information using the AgFA@ database to measure technology adoption and its economic impact on the dairy business. Web Site Address: (http://www.uwex.edu/ces/dairymod/index.cfm).

Babcock Institute

The Babcock Institute for International Dairy Research and Development at the University of Wisconsin–Madison offers programs to foreign nationals. Brian Holmes and David Kammel (UW- Madison) have served as instructors for the Babcock Institute programs.

Farm Business Transfers

Returning to the Farm (RTTF) is a project designed to address the human, legal and financial risks involved into the transfer of the farm to the next generation. It attempts to reach college juniors and seniors who are planning on returning to their home farming operations. The project includes two weekend sessions held in the fall and spring. Each student and the farming family members are required to attend both sessions. Communication, conflict management, financial analysis of the farm, strategic planning, business arrangements, retirement planning and estate planning are covered in the two sessions. Consultations are offered between the two sessions to analyze the financial capacity of the farm. One hundred fifteen (115) people representing 34 farm families have participated in a Returning to the Farm workshop since 2005. Evaluations from the workshops indicate participants used the tools provided to help analyze their farms and develop farm succession plans. RTTF was partially funded through a competitive grant from the North Central Region Risk Management Education Center.

Transferring the Farm in a High Stakes Era

Transferring the Farm in a High Stakes Era is a series of one-day workshops addressing the issues commonly associated with farm succession. The workshops included farm tax, business entities, dealing with the 5Ds (death, divorce, disability, disaster, disagreement), financial, business and retirement planning. The workshops are day-long programs. In 2010 and 2011 a total of ten workshops were held and reached approximately 500 participants. Locations: Black River Falls, River Falls, Rice Lake, Baraboo, Waldo, Jefferson, Ladysmith, Abbotsford, Monroe and Chilton.

Heart of the Farm- Women in Agriculture

The Heart of the Farm Conference Series, co-coordinated by Jenny Vanderlin and Joy Kirkpatrick, continues to empower Wisconsin farm women in production, price, and financial, legal and human areas of risk management education. The Heart of the Farm Conferences brings women together in a professional setting and increases their knowledge and competence in farm business management skills and production. These conferences are a vehicle to decrease the social isolation experienced by many

farm women by providing opportunities to network with their counterparts. Since 2009, the Heart of the Farm Conferences have been partially funded by a USDA RMA Small Sessions grant. The funding provides approximately $10,000 ($19,982 in 2010) to support the conferences series. CDP has been able to offer at least eight workshops each year throughout the state with this grant funding. The funding covers speakers' costs, travel costs, materials and supplies. Annie's Project is another opportunity for women farmers to connect with risk management resources and to network with each other. Annie's Project participants usually meet with instructors usually four-to-six times to train farm women to manage agricultural information systems, engage in critical decision-making processes, and build support networks with other women throughout the state. In 2010, an Annie's Project for beginning women farmers and valued added farm enterprises was offered in Dane and Walworth Counties. These two groups met six weeks in a row and learned about business planning, financial management, marketing research and state food/health regulations for value added enterprises. This Annie's Project series had a total of 52 participants and was partially funded through a separate competitive grant from the North Central Risk Management Education Center.

CDP staff developed and produced video highlighting three Wisconsin women farmers who have attended Heart of the Farm conferences and how attending has impacted them and their businesses.
Heart of the Farm Part 1: (http://www.youtube.com/watch?v=xjDesYfafoY).
Heart of the Farm Part 2: (http://www.youtube.com/watch?v=Yl150QKODfE&feature=channel).

Risk Management

The UW-Extension's Farm and Risk Management (FARM) self-directed team, in cooperation with the CDP staff, developed the risk management and business planning modules of the Ag Ventures curriculum. Kevin Bernhardt (UW-Platteville), Gregg Hadley (UW-River Falls), and Jenny Vanderlin (UW-Madison) support these educational programs which are used by farm managers, county extension agents, and agricultural professionals. Web Site: (http://www.uwex.edu/ces/ag/teams/risk/).

Sustainable Wisconsin Dairy Farm Financial Management

The objective of the project is to equip Wisconsin dairy producers to better prepare for periods of cash flow shortages and execute enhanced abilities and financial plans in the face of extreme price volatility as indicated by their specific personal financial situation. The ultimate goal is increased dairy farm financial security and reduced producer stress. The Working Capital (WC) Excel-based decision making tool consists of an integrated set of financial statements. It is intended to assist dairy producers in identifying annual cash flow balances for the recent past (1-2 years); project expected incomes and expenses for the coming year and identify cash shortfalls well in advance of occurrence. Changes in solvency levels are calculated as well as liquidity. The projection may be updated in "real-time" through monthly entries of actual incomes and expenses.

Wisconsin Assessment Center for Dairy Farm Owners/Managers

In today's changing farm environment, dairy farm managers are required to take on more of a managerial role. Specialists from the CDP and a team of UW-Extension agricultural agents designed the Management Assessment Center (MAC) for Dairy Managers. The assessment center curriculum was developed, tested and implemented to help dairy farm managers understand their own competency levels as they relate to selected managerial attributes. Each assessment center includes a two-day program where producers participate in a series of activities which help assessors evaluate individual managerial strengths and areas needing improvement. Following the program, producers are given a detailed individualized report and a personal consultation. A resource guide is provided that assists them in developing a plan for self-improvement. Through impact and publicity, the MAC for Dairy Farmers has received interest from new audiences and agricultural organizations to develop and hold a MAC specifically for them. In the past two years, the team has worked with the Professional Dairy Producers of Wisconsin (PDPW) and the Wisconsin Crop Production Association (WCPA) to provide a MAC for

their members to attend. In addition, staff has worked with UW-River Falls to host a MAC for juniors and seniors who plan on going into farming themselves or back to their family farm after graduation. To date, ten (10) assessment centers have been offered and 120 dairy managers (current, potential) agricultural professionals have participated in the assessment program. Evaluation results have been extremely encouraging and there is an increasing demand to modify the curriculum for other commodity groups as well. Web Site: (http://cdp.wisc.edu/MAC.htm).

CDP Publications

Barnett, Ken. 2011. "The New Social Security Contribution Rate for 2011." Includes State & Federal laws and provisions regarding employment. Center for Dairy Profitability.

Barnett, Ken. 2009. The Wisconsin Opportunity Minimum Wage and Agricultural Employee Wage Rates. Center for Dairy Profitability. Includes State & Federal laws and provisions regarding employment.

Barnett, Ken. 2009. The New Wisconsin Minimum Wage and Agricultural Employee Wage Rates. Center for Dairy Profitability. Includes State & Federal laws and provisions regarding employment.

Barnett, Ken. 2009. Agricultural Employment Guidelines, 2009. Center for Dairy Profitability. Includes State & Federal laws and provisions regarding employment, July 2009.

Bernhardt, Kevin. 2010. Marketing Tools, Strategies, Planning and Mindset / Bernhardt, Kevin. UW-Platteville, Center for Dairy Profitability.

Bernhardt, Kevin. 2010. Marketing 101: Dipping Your Toes in the Shallow End of the Marketing Pool / Bernhardt, Kevin. UW-Extension, Center for Dairy Profitability.

Bernhardt, Kevin. 2010. Marketing and Management: Avoid Playing Eeny, Meeny, Miny Mo with your Future" UW-Platteville, Center for Dairy Profitability.

Bernhardt, Kevin. 2009. Global Economy, Recovery, and Linkage to Agriculture." Kevin Bernhardt, UW-Platteville, Center for Dairy Profitability.

Bolton, Ken. 2011. "Farm Liability Insurance." / and Phil Harris, Shannon Mirus. University of Wisconsin-Extension (A3917), Center for Dairy Profitability.

Bolton, Ken. 2011. "Managing Cash Flow to Maintain Profit." Wisconsin Agriculturist Magazine.

Bolton, Ken and Jenny Vanderlin. 2011. "2009 Financial Benchmarks on Selected Wisconsin Dairy Farms", University of Wisconsin, Center for Dairy Profitability.

Bolton, Ken and Jenny Vanderlin. 2011 "Milk Production Costs in 2009 on Selected Wisconsin Dairy Farms", University of Wisconsin, Center for Dairy Profitability, April 2011.

Bolton, Ken. 2010. "Key Fundamentals of Successful Teams." Wisconsin Agriculturist Magazine.

Bolton, Ken. 2010. "Estimating Dairy Cow Feeding Consumption and Cost." Eastern Diary Business Magazine.

Bolton, Ken and Jenny Vanderlin. 2009. "2007 Financial Benchmarks on Selected Wisconsin Dairy Farms", University of Wisconsin, Center for Dairy Profitability.

Bolton, Ken and Jenny Vanderlin. 2009. Milk Production Costs in 2007 on Selected Wisconsin Dairy Farms.

Bolton, Ken. 2009- . Wisconsin Calculated Milk Cost of Production. Monthly Report.

Brannstrom, Arlin. 2011. "Wisconsin Agricultural Land Prices, 2005-2010" University of Wisconsin, Center for Dairy Profitability.

Brannstrom, Arlin. 2010. "Wisconsin Agricultural Land Prices, 2001-2009" University of Wisconsin, Center for Dairy Profitability. February 2010.

Harris, Phil. 2011. Family Estate Planning in Wisconsin. / Karen Goebel, Mary Meehan-Strub, and Linda Roberson. . University of Wisconsin-Extension (B1442), Center for Dairy Profitability.

Kirkpatrick, Joy (Forthcoming). Retired Farmer – An Elusive Concept. In M. Lobley & J. Baker (Eds.) Keeping it in the Family: International perspectives on succession and retirement on family farms. Surrey, England: Ashgate Publishing Ltd.

Kirkpatrick, Joy. 2010. Heart of the Farm Newsletter.

Kriegl, Tom. "What Milk Price Premium Can Be Paid to Produce Organic Milk with no Grain?" Center for Dairy Profitability. University of Wisconsin-Madison, UW-EX. November 2010. 3 pages.

Kriegl, Tom. "Preliminary 2009 Farm Financial Performance Update." Center for Dairy Profitability. University of Wisconsin-Madison, UW-EX. August 2010. 3 pages.

Kriegl, Tom. "Why is Credit Tighter Now than Six Months Ago Despite Higher Milk Prices?" #1 in series. Center for Dairy Profitability. University of Wisconsin-Madison, UW-EX. June 2010. 1 page.

Kriegl, Tom. "How Asset Valuation can Hurt You." #2 in series. Center for Dairy Profitability. University of Wisconsin-Madison, UW-EX. June 2010. 1 page.

Kriegl, Tom. "The Most Trustworthy Number on a Balance Sheet Current Market Value (CMV) of Assets can be Dangerous to Your Farm's Financial Health." #3 in series. Center for Dairy Profitability. University of Wisconsin-Madison, UW-EX. June 2010. 1 page.

Kriegl, Tom. "Asset Values May Have Three Sources That Are Not the Same." #4 in series. Center for Dairy Profitability. University of Wisconsin-Madison, UW-EX. June 2010. 1 page.

Kriegl, Tom. "The Importance of Debt Structure and Balancing Loan Terms with Asset Life." #5 in series. Center for Dairy Profitability. University of Wisconsin-Madison, UW-EX. June 2010. 1 page.

Kriegl, Tom. "What is Your Level of Profitability? Taking it to the Next Level!" Adapted from similar articles on UWEX Responds website. for article in the Wisconsin Agriculturalist Magazine, May 2010 Center for Dairy Profitability. University of Wisconsin-Madison, UW-EX. May 2010. 2 pages.

Kriegl, Tom. "Looking Forward to 2010 and Back to 2009." Center for Dairy Profitability. University of Wisconsin-Madison, UW-EX. June 2010. 8 pages.

Nicholsosn, Charles F. and Mark Stephenson. "Analysis of Proposed Programs to Mitigate Price. Volatility in the U.S. Dairy Industry."
http://dairy.wisc.edu/Volatility/Analyses_of_Volatility_Programs.pdf, September, 2010.

Stephenson, Mark. "Dairy Outlook—2011", American Agriculturalist, January, 2011.

Stephenson, Mark. "Feed Costs Up, Milk Prices Flat in 2011", Hoards Dairyman, December, 2010.

Stephenson, Mark. "2011 Dairy Outlook", 2011 Agribusiness Outlook Handbook, Ithaca, NY. December, 2010.

Stephenson, Mark and Bob Cropp. "Outlook for Dairy". Wisconsin Status of Agriculture, Dairy Chapter, January, 2011.

Stephenson, Mark. "Dairy Policy and Milk Pricing Plans", 4-State Dairy Nutrition and Management Conference, May, 2011.

Sterry, Ryan and Jenny Vanderlin. 2011. "Wisconsin AgFA Dairy Farms Profitability, 2009 Production Year.", University of Wisconsin, Center for Dairy Profitability.

Vanderlin, Jenny. 2009. AgFA Benchmark Reports for the same 35 farms in 2006-2008, Preliminary Data.

Zander, John. 2008. Wisconsin AgFA Dairy Farms Profitability Report for 50-100 Herd Size, 2005.

CDP Internet Sites

Center For Dairy Profitability Website
http://cdp.wisc.edu
Since 1995, the Center for Dairy Profitability has maintained a home page. The new homepage design was created to enhance access and retrieval of educational information. This site has a wealth of information of value to dairy producers and other professionals making economic decision in their business.

Heart of the Farm Website
http://www.uwex.edu/ces/heartofthefarm
Developed in 2002, this site promotes educational programs, conferences, and resources of interest primarily to farm women.

Team Forage – Harvest and Storage Web Site
http://www.uwex.edu/ces/crops/uwforage/storage.htm
In conjunction with the Harvest and Storage Workgroup of the UW-Extension Forage Team, Brian Holmes has developed a webpage dedicated to improving decision making about forage harvest and storage. This work has been instrumental in improving producers' understanding of the relationship between proper forage storage and reduced loss.

Dairy Modernization Website
http://www.uwex.edu/ces/dairymod/
Developed in 2006 this site provides educational materials and links for farmers and other agricultural professionals on technology of modernizing the dairy farm.

FARM Team Website
http://www.uwex.edu/ces/farmteam
Release in Fall 2007.

Appendix A
Industrial & Economic Development Research Program (IEDR) Grants
2009-10

Investigator	Department	Amount	Cooperating Co.	Title
Suman Banerjee	Computer Science	$49,640	MadCity Broadband, Madison	*Bridging the Digital Divide to Rural Wisconsin*
Lawrence Bank	Civil & Environmental Engineering	$35,288	Eppstein Uhen Architects, Madison & Milwaukee	*Use of System Dynamics as a Decision-Making Tool in Sustainable Building Design*
Dan Botez	Electrical & Computer Engineering	$50,000	Intraband, Madison	*Solid-State Infrared Lasers for Food-Package Marking*
Richard Burgess	Oncology	$48,781	Semba Biosciences, Madison	*Monoclonal Antibody Purification Using Simulated Moving Bed Chromatography*
Andreas Friedl	Pathology & Laboratory Medicine	$34,760	Bellbrook Labs, Madison	*Improved Cell-based Assays Personalized Medicine*
Gregory Harrington	Civil & Environmental Engineering	$50,000	AquaMost LLC, Madison	*Photoelectrocatalytic Oxidation to Inactivate Microbes in Drinking Water*
Hasan Khatib	Dairy Science	$15,000	Genez Cooperative, Shawano	*Validation of Fertility Gene Effects in a Commercial Dairy Cattle Population*
Lingjun Li	Pharmacy	$46,230	Promega, Madison	*Implementation of Cross-linked Trypsi Aggregate for High Throughput Proteomics*
Charles Mistretta	Medical Physics	$50,000	Quantumspex, Madison	*Adaptation of Real Time Medical Imaging Algorithms for Night Vision*
Dan Negrut	Mechanical Engineering	$50,000	P&H Mining, Milwaukee	*Effective Engineering Design through Computer Modeling and Simulation*
Frank Pfefferkorn	Mechanical Engineering	$49,507	Performance Micro Tool, Janesville	*Durable Nanocrystalline Diamond Coated Cutting Tools*
Heidi-Lynn Ploeg	Mechanical Engineering	$50,000	Vantus Technology Corp, Waukesha	*Presurgical Planning & Manufacturing System for Personalized Orthopedic Implants*
Scott Reeder	Radiology	$49,875	GE Healthcare, Waukesha	*Validation of Quantitative Biomarkers of Fatty Liver Disease using MRI*
Timothy Shedd	Mechanical Engineering	$49,684	Hydro-Thermal Corp, Waukesha	*Injecting Innovation: Enabling New Markets for Direct Steam Injection Heating*
Lih-Sheng Turng	Mechanical Engineering	$48,976	Microscopy Innovations, Madison	*Accelerated Microcopy and Automated Tracking of Pathology Specimens*
Michael Zinn	Mechanical Engineering	$50,000	Marvel Medtech, Madison	*MRI-Guided Robotic Biopsy System for Breast Cancer Diagnosis and Treatment*

Appendix B
Industrial & Economic Development Research Program (IEDR) Grants
2010-11

Investigator	Department	Amount	Cooperating Co.	Title
Suman Banerjee	Computer Science	$50,000	Madison Metro Transit, Madison	*WiRover: A Technology for High-Bandwidth Internet Connectivity to Vehicles*
David Beebe	Biomedical Engineering	$50,000	Bellbrook Labs, Madison	*Improved on Chip Diagnosis of Asthma*
Riccardo Bonazza	Engineering Physics	$50,000	Renewegy, Oshkosh	*Optimization of Wind Turbine Blade Design and Operation*
Mark Cook	Animal Sciences	$50,000	aOvatechnologies, Inc, Madison	*Egg Antibody to Improve Broiler Performance*
Srinivasan Damodaran	Food Science	$50,000	Grande Cheese Company, Brownsville	*Whey-derived Nutraceutical Lipids*
Benjamin Darien	Medical Sciences	$50,000	ioGenetics, Madison	*Anticryptosporidial Efficacy of Pre-colostrally Delivered Directed Biocide*
Derek Hei	Waisman Center	$50,000	ThermoScientific, Madison	*Development of Online NIR Analysis for Use in Stem Cell Bioreactors*
Sean Palecek	Chemical & Biological Engineering	$50,000	Invivosciences LLS, Waukesha	*Enhancing Contractility in Cardiac Myocytes Derived from Human iPS Cells*
Frank Pfefferkorn	Mechanical Engineering	$50,000	NCD Technologies, Madison	*Ultra-Thin Diamond Coatings for Micro Cutting Tools*
Vadim Shapiro	Mechanical Engineering	$50,000	Intact Solutions, LLC, Sun Prairie	*Direct Analysis of Digitized Sculptures and Installations*
Kevin Turner	Mechanical Engineering	$50,000	nPoint, Inc, Madison	*Nanomechanical Force Sensor with Feedback for Materials Characterization*
Ray Vanderby	Orthopedics & Rehabilitation Medicine	$50,000	Echometrix, LLC, Madison	*An Ultrasound Method to Measure the Load Bearing Function of Tendons & Ligaments*
Michael Zinn	Mechanical Engineering	$50,000	Simplex Scientific, Middleton	*Minimally Invasive Active Limb Deformity Correction Device*

Appendix C
Applied Research Program Awards
2009-10

Investigator	Campus	Amount	Title
Joseph Wu	UW Platteville	$42,630	*Toward Industrial Scale Fabrication of Nanowire-Based Devices*
Jennifer Miskowski	UW La Corsse	$28,389	*Development of Microscale Assays to Screen for Novel Anthelmintic Drugs*
Nathan Bowling	UW Stevens Point	$33,688	*Development of Two-Dimensional Metallorganic Networks for Potential Application in Photovoltaics*
Charles Gibson	UW Oshkosh	$37,804	*High Performance Electrical Storage (EES) Devices*
Junhong Chen	UW Milwaukee	$47,149	*Nanoscale Corona Discharges*
John Droske	UW Stevens Point	$49,956	*Polymers and Copolymers with Controlled Bioresorption for Biomedical Applications*
Cheng-Chen Huang	UW River Falls	$49,681	*Screening for Potent Attenuators of Heart Failure Progression Using a Zebrafish Heart Failure Model*
Jeri-Anne Lyons	UW Milwaukee	$39,930	*Collaborative Proposal: A Role for dbl-b E3 ubiquitin ligase in the Balance between Tolerance and Autoimmunity*

Appendix D
Applied Research Program Awards
2010-11

Investigator	Campus	Amount	Title
Eric Brown	UW Whitewater	$35,954	*Development of Fluorescently Labeled Titanium Dioxide (Ti02) Nanoparticles to Enhance Cleaning and Bio-decontamination of Surfaces*
Jason D'Acchioli	UW Stevens Point	$26,932	*Development of Two-Dimensional Metallorganic Networks for Potential Application in Photovolaics: Synthetic Avenues to Processible Materials*
Bertram Ezenwa	UW Milwaukee	$49,963	*Laser Focused Ablation System for Artificial Hip Stem Removal*
Toivo Kallas	UW Oshkosh	$50,000	*Metabolic Engineering of Isoprene Production in a Halotolerant Cyanobacterium*
Karland Kilian	UW Platteville	$50,000	*Toward Production of Hybrid TiO2 Nanowire Graphene Electrodes for Advanced Batteries*
Nikolai Kouklin	UW Milwaukee	$49,878	*Nanoarray-based Optical Sensors*
David Lewis	UW Eau Claire	$50,000	*New Warfarin-Based Oral Anticoagulants*
Meir Russ	UW Green Bay	$35,729	*Entrepreneurship in the Native American Populations in Wisconsin: Barriers, Issues, Policies and Opportunities*
Mike Zorn Ken Smith	UW Green Bay UW Stout	$24,998 $25,000	*Fabrication and Evaluation of Photocatalytic PEM Hydrogen Fuel Cells*

Appendix E
Center for Dairy Profitability Research and Outreach Grants
Awarded from External Sources

Investigator	Funding Source	Amount	Title
Ken Bolton	North Central Region Risk Management Education Center University of Nebraska- Lincoln	$47,015	*A Sustainable Wisconsin Dairy farm Financial Management Model*
Arlin Brannstrom	North Central Region Risk Management Education Center University of Nebraska- Lincoln	$49,741	*North Central Extension Farm Management Committee Lease Modernization*
Joy Kirkpatrick	USDA-RMA	$19,982	*Heart of the Farm – The Next Level*
Joy Kirkpatrick Jenny Vanderlin	North Central Region Risk Management Education Center University of Nebraska- Lincoln	$43,565	*Annie's Project for Value Added and Beginning Wisconsin Farm Women*
Joy Kirkpatrick Jenny Vanderlin	USDA RMA Grant	$10,000	*Heart of the Farm- WIA 2011*
Joy Kirkpatrick	North Central Region Risk Management Education Center University of Nebraska- Lincoln	$49,871	*Retired Farmers – An Elusive Concept? Addressing the Real and Perceived Barriers to Farmer Retirement.*
Jenny Vanderlin	USDA RMA Grant	$9,999	*Improved Risk Management via Accrual Accounting.*
Jenny Vanderlin, Joy Kirkpatrick	North Central Region Risk Management Education Center University of Nebraska- Lincoln	$25,000	*Heart of the Farm- Greenfields*
Jenny Vanderlin	North Central Region Risk Management Education Center University of Nebraska- Lincoln	$36,628	Success for Small Beginning Dairy Farmers.
Jenny Vanderlin Stan Schraufnagel	USDA-RMA	$14, 453	*Cash Accounting Using Quickbooks*
Jenny Vanderlin Stan Schraufnagel	North Central Region Risk Management Education Center University of Nebraska- Lincoln	$16,649	*Got Profit? Beyond the First Step*
Jenny Vanderlin	North Central Region Risk Management Education Center University of Nebraska- Lincoln	$16,450	*Assessing Management Skills of Farm Managers*
Jenny Vanderlin Stan Schraufnagel	USDA-RMA	$9,943	*Farm Financial Accounting Workshops Using AAIMS and Quickbooks*
Jenny Vanderlin	North Central Region Risk Management Education Center University of Nebraska- Lincoln	$42,000	*Application of AgFA to Assist Young Farmers to Improve Financial Decision-making in an Increasing-Risk Environment*
Total External Funding		**$391,296**	